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ABSTRACT

This investigation presents activities related to the geological history of Ohio and Ohio's mineral wealth. Energy is discussed briefly as it relates to high sulfer content Ohio coal. The lessons are presented in the form of a teachers' guide and a students' guide. In the teachers' guide, an overview of the study is followed by the prerequisite student background needed for successful completion of the work. Materials and objectives are listed and suggestions for acquisition of specimens are described. (SA)

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OEAGLS- Oceanic Education Activities for Great Lakes Schools

EVIDENCE OF ANCIENT SEAS IN OHIO

by

Susan Leach Upper Arlington Public Schools
and
Victor J. Mayer The Ohio State University

Ohio Sea Grant Program
Charles E. Herdendorf, Program Director
Victor J. Mayer, Principal Investigator

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OEAGLS INVESTIGATION #10

Completed May, 1979

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INVESTIGATION EVIDENCE OF ANCIENT SEAS IN OHIO

INTRODUCTION

Did you know that you may be living on a sea bottom? Did you know that Ohio is a major producer of minerals? In 1969, Ohio was fifth among all states in the amount of coal mined, second in the amount of clay, dolostone, and limestone, and third in the amount of salt, sandstone, sand and gravel. Most of these sediments as well as shale, clay, oil, and natural gas which are also mined here indicate that Ohio has in the past been covered by shallow seas.

OBJECTIVES

When you have completed this investigation you will be able to:

1. Describe the environments in which each of the following sediments would be deposited: clay, silt, mud, shale, sand and sandstone; limestone and dolostone; salt and gypsum; coal, oil, natural gas.

2. Explain the relationship between the geological history of Ohio and its mineral wealth.

3. Explain why some areas of Ohio do not have as much mineral wealth as other areas.

ACTIVITY A HOW WERE OHIO'S MINERALS FORMED?

MATERIALS

Jar with sediment and water; samples of rock; microscope, pyrex watch glass, salt solution, and heat source.

PROCEDURE

All of the rock types common to Ohio are sedimentary in origin. One type is made of pieces of rock that were broken or worn from larger chunks. Clay, sand and gravel are examples of sediments that are fragments of rock. These fragments are then cemented together to form rocks such as shale and sandstone. These are called fragmental rocks. Other types of sedimentary rocks form from plants and animals which died and fell to the bottom of lakes, swamps and oceans. Their hard parts are cemented into rocks such as limestone, and dolomite. These types of rocks are called organic rocks. The soft parts of the plants or animals form coal, oil, and natural gas. The third type of sedimentary rock forms from the evaporation of water. Minerals that are dissolved in the water precipitate to form minerals such as salt and gypsum. These are called chemical rocks.

In this activity you will examine how the three types of sedimentary rocks form.

1. Shake the jar filled with sediment and water. Allow the sediment to settle. Describe the sediment.

_____

You should have observed that different sizes of sediments settled at different places. This happens to sediments carried by streams and rivers as they enter a lake or ocean. The large heavy pieces settle out first, close to shore. The smaller pieces are carried by slow currents out into deeper water.

Shale is made up of clay, silt, and mud. Such very fine-grained sediments are the last to settle out of streams and currents. Therefore, they will be carried out furthest in a lake or ocean. Sediments making up shale are so fine grained that they cannot be seen, even under a microscope. Also, shale is usually dark colored and made up of very thin layers.

2. Pick out the sample of shale from your rock tray. Write down a description of the sample.

_____

_____

Sandstone is made up of grains of sand. The grains are large enough so that you are able to see the individual grains. If you have walked along a beach recently you may recall seeing sand. It is usually found deposited along the edge of lakes and oceans.

3. Identify the sample of sandstone from your rock tray. Describe its characteristics.

_____

_____

Limestone and dolostone are formed of the chemicals calcium carbonate and magnesium carbonate. These chemicals are found in shells and skeletons of many marine and freshwater animals and plants. The remains of these plants and animals accumulate at the bottom of the lake or sea. When this sediment is buried it will change into rock. Sometimes you can find fossils in these rocks. Often, however, the plant and animal remains have been so broken and ground up that individual pieces cannot be identified. Any carbonate will react chemically with hydrochloric acid. This will cause a fizzing to occur.

4. Identify the samples of limestone and dolostone from your rock tray. Describe the two rocks.

_____

_____

_____

Salt and gypsum form from sea water when it evaporates. This can happen when sea water is cut off from the ocean. If the area is hot and dry, then the water will evaporate and deposits of salt and gypsum will be left. Salt can be identified by its taste. Gypsum is very soft. You can scratch it with your fingernail.

5. Place a drop of salt solution in the watch glass. Then place it on the stage of the microscope and examine it. Describe what you see.

_____

_____

6. Using a pair of tongs, hold the watch glass over a heat source until all the water has evaporated. After the glass has cooled, place it under the microscope. Describe what you see.

_____

_____

7. Identify the samples of salt and gypsum from your rock tray. Describe each.

_____

_____

Geologists have not been able to actually observe processes which cause coal, oil, and natural gas to form. They believe, however, that these minerals form from partially decayed plant or animal matter exposed to high pressure and high temperature. Coal is thought to form from plant matter that accumulated in large swamps. Frequently you can find leaves and stems of plants in coal. Coal is black and relatively light weight.

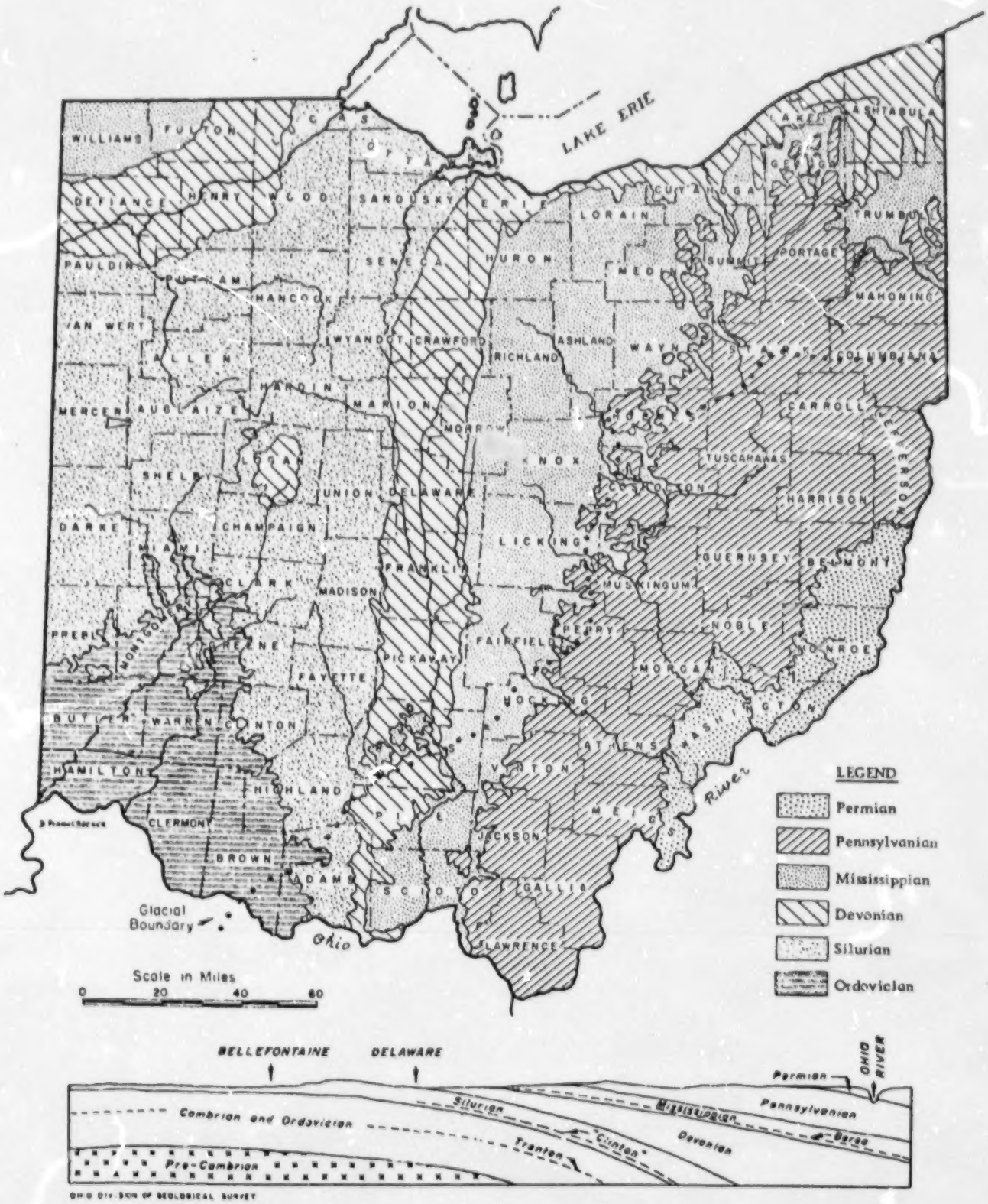


Figure 1. GEOLOGIC MAP OF OHIO

8. Identify the sample of coal from the rock tray. Describe it.

_____

_____

Oil and gas are thought to form in mud deposited at the bottom of oceans and seas. Later, they move from the shales formed from these muds into sandstones and limestones where they are held until found by a geologist or driller.

The rocks and minerals found in Ohio were depostied in layers one on top of another. Some of these layers were eroded. Some were tilted and broken. Some of the history of Ohio kept in those rocks was destroyed. What is left, however, tells geologists about the events that occurred in Ohio long before man and even the dinosaurs lived.

ACTIVITY B WHAT DO OHIO'S MINERALS TELL ABOUT ITS HISTORY?

MATERIALS None.

PROCEDURE Use Figures 1 through 6 to answer the following questions:

1. Find the county you live in on the map in Figure 1. What is the age of surface rock in your county?

_____

2. Find your county on Figures 2-6. What rock or minerals are obtained in your county?

_____

3. What was the environment in your county when its rocks were formed?

_____

4. Where would you go in the state to find ancient swampy areas?

_____

5. Where is most shale mined?

_____

6. What was the environment of that area of Ohio (from question 5) when the sediments were being deposited.

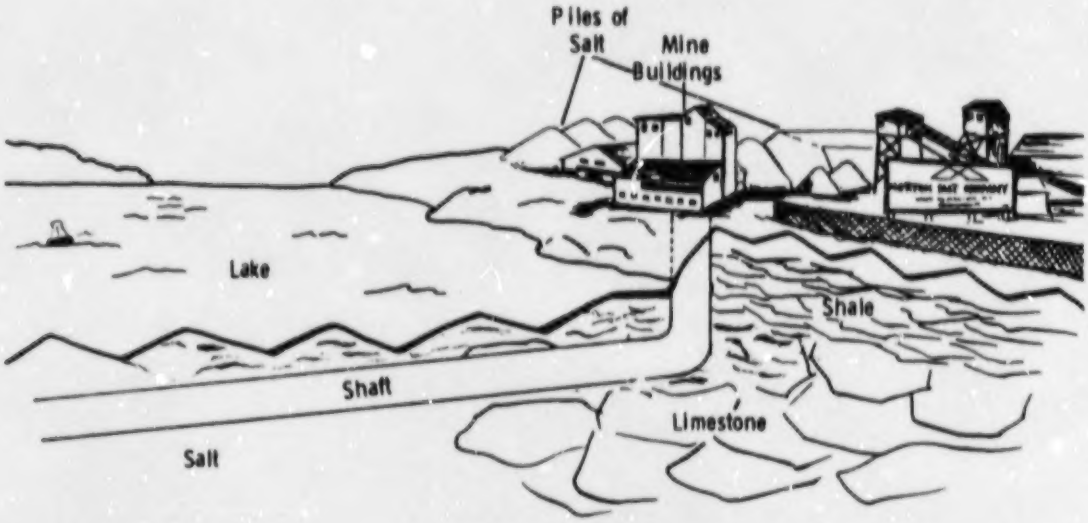
_____

7. Refer to Figure 1. Where are the oldest surface rocks found?

_____

Salt is found in two types of deposits. Rock salt is found in strata like other sedimentary rocks. Natural brines are mixtures of water and salt that fill the pore spaces of sedimentary rocks.

Approximately ¼ of Ohio is underlain by rock salt. This area extends east of a line from Lorain (on Lake Erie) to Marietta (on the Ohio River). The Morton Salt Company mine at Fairport actually obtains its salt from a mine in the rocks below Lake Erie.



Picture above is a cutaway view of the mine and the rocks below it and Lake Erie.

Natural brine is found under about half of the state. It is found east of a line from Lorain to Portsmouth (on the Ohio River). These natural brines are sea water that was trapped as sediments were deposited and changed into rock. They are "fossil sea water." During early times in Ohio, those brines were used as a source of salt. Now they are important sources of a variety of chemicals used in industry.

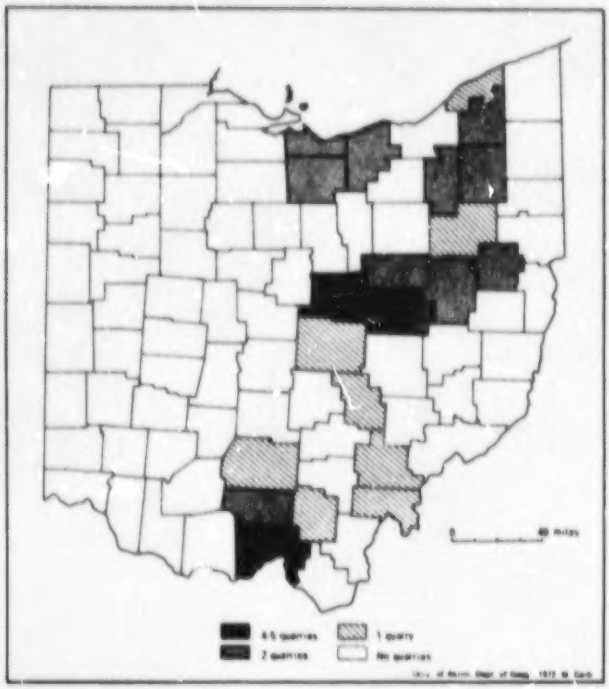


Figure 2. Active sandstone quarries (Ohio Division of Mines, 1970); no counties reported three active quarries.

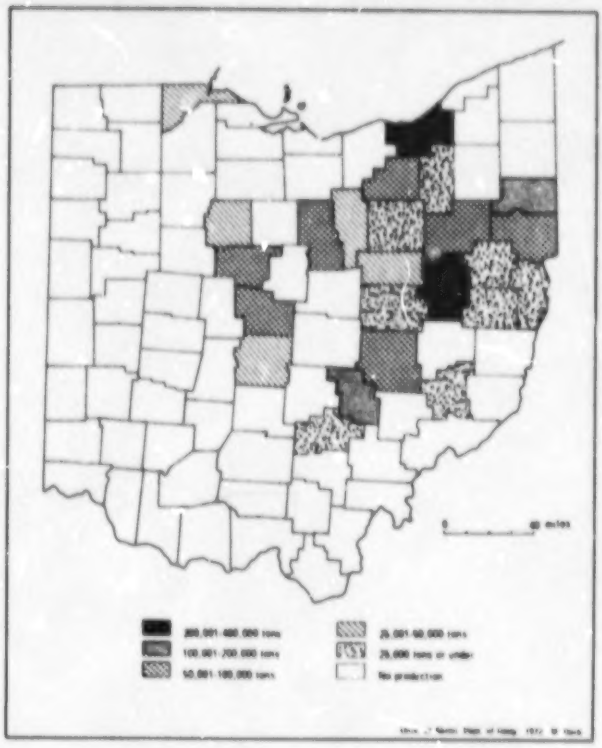


Figure 3. Shale production in 1969 (Ohio Division of Mines, 1970); no counties reported between 200,001 and 300,000 tons.

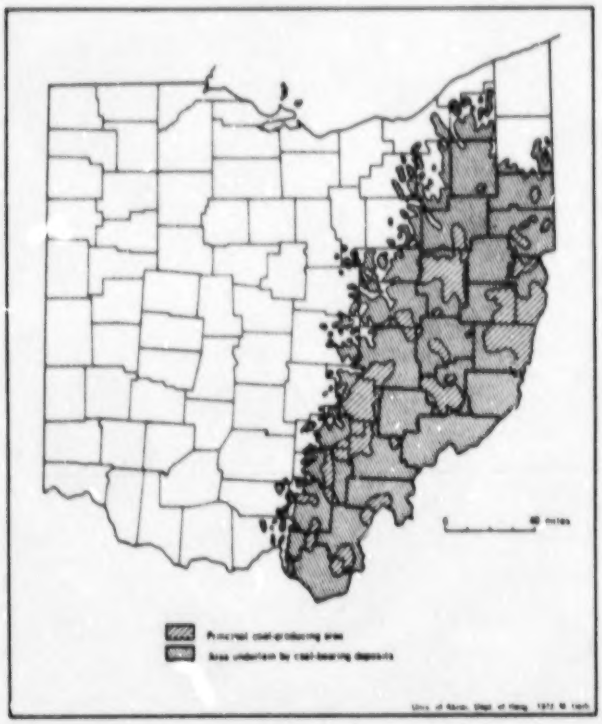


Figure 4. Coal deposits in Ohio (Brant and DeLong, 1960).

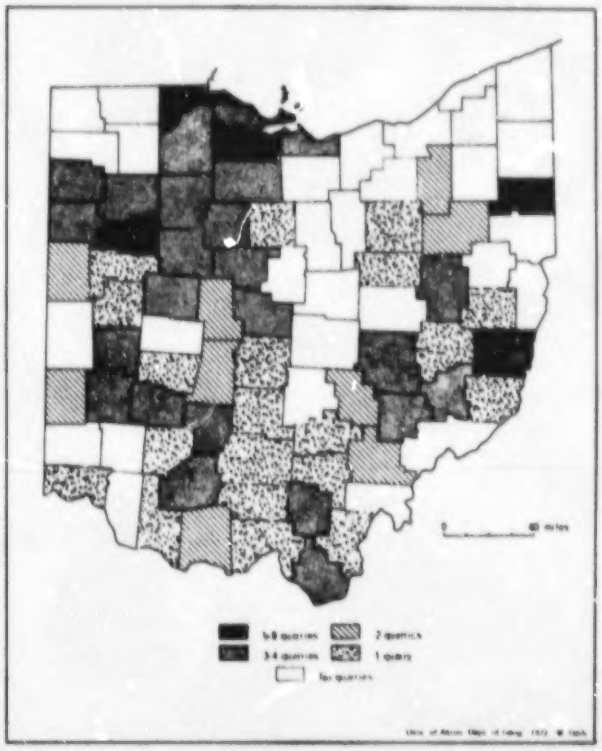


Figure 5. Active limestone quarries in Ohio in 1969 (Ohio Division of Mines, 1970).

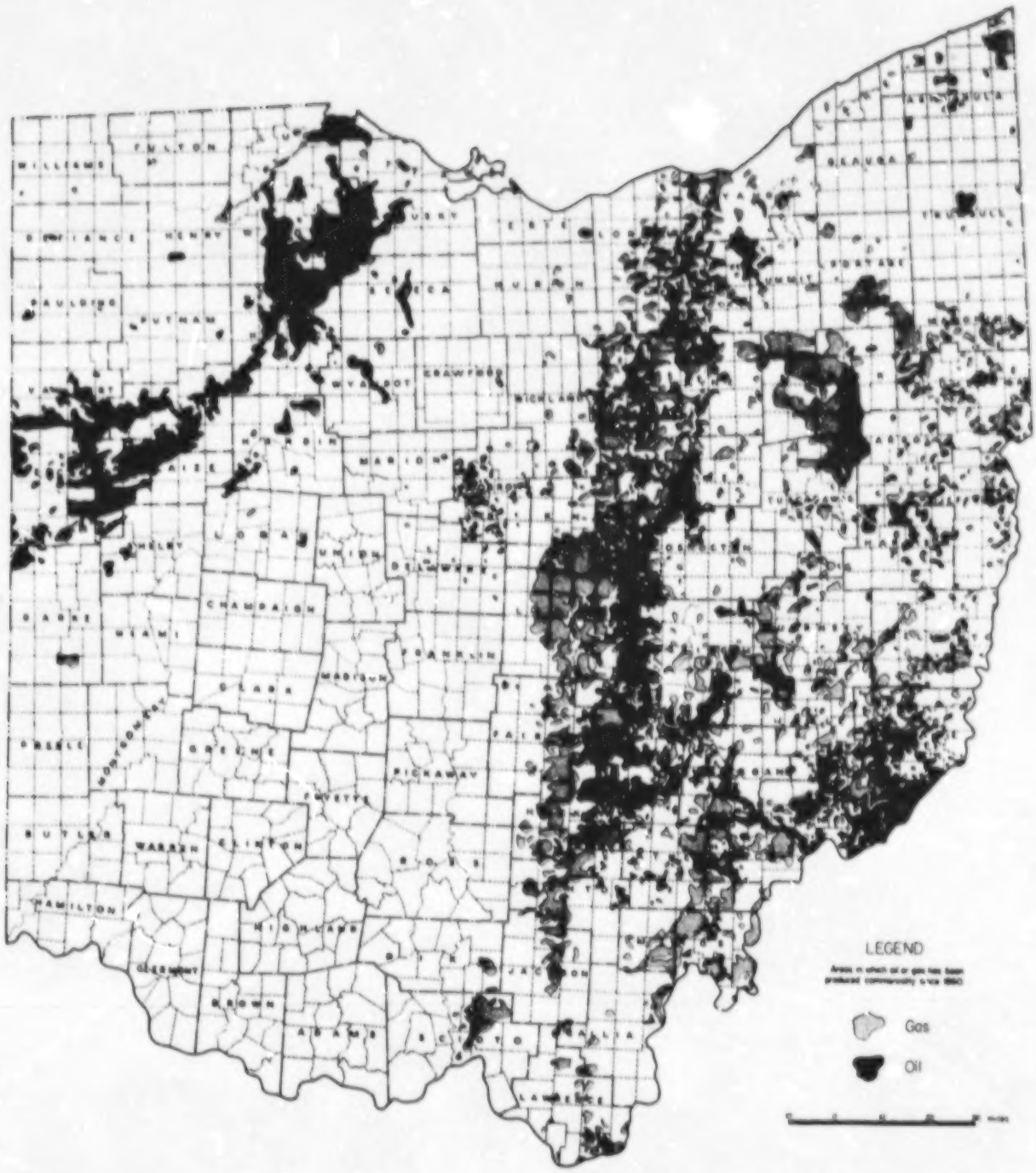


Figure 6. Oil and gas fields in Ohio (Ohio Division of Geological Survey).

8. Fairport is located in Lake County. What age of rock is at the surface at the salt mine?

_____

9. Salt is found in Silurian rocks. Where would they be found with reference to Fairport mine?

_____

10. Natural gas and oil are thought to occur below Lake Erie. What part of Lake Erie would have the greatest potential for finding oil and gas? Refer to Figure 6.

_____

11. Why do you think very little has been done to explore for gas and oil under Lake Erie? What types of problems would be encountered?

_____

_____

12. Where in Lake Erie would you go to find limestone or dolostone? Refer to Figure 5.

_____

13. Coal is found in rocks of Pennsylvanian age in Ohio. Do you think it might ever be mined from under Lake Erie? Explain. Refer to Figure 1.

_____

_____

Ohio has had many mineral resources. They, in part, are the reason that industry has been such an important part of the economy of the state. These resources, however, are nonrenewable. Although the processes that formed them are still going on in the world's oceans and seas, they are so slow that they do not result in new oil, gas or rock for use by our civilization. In just a few decades, we have used most of the oil and gas that formed in our country over millions of years of time. We must, therefore, look to other types of energy for continued support of our industry. One such source is the sun. Oil and gas are actually sources of solar energy that was captured by plants and animals and then preserved by geological processes. We now need to learn how to use solar energy directly. It could provide most if not all of our energy needs if we just knew how to harness it in an economical way.

QUESTIONS

1. List the types of minerals that have been found in Ohio.

2. Describe how the three types of sedimentary rocks found in Ohio (fragmentary, organic and chemical) are formed.

3. How is coal formed? Oil and gas?

4. List the types of minerals that are found along or under Lake Erie.

5. Where in the world today would you expect to find sediments forming that will become limestone? Coal? Sandstone?

6. How did the environment in Ohio change from the time when the youngest rocks were formed?

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TEACHER GUIDE

OEAGLS INVESTIGATION #10

Completed May, 1979

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OVERVIEW

In this investigation, students study the sedimentary rocks commonly found in Ohio. These rocks are then related to the geologic history of the state and to the types of environments that must have existed when they were formed. The presence of many mineral resources, especially oil and gas, under Lake Erie is mentioned and students are asked to discuss problems with exploiting those resources.

PREREQUISITE STUDENT BACKGROUND

Students should have had some experience in identifying sedimentary rocks and the common minerals. They should also be familiar with the geologic time scale.

MATERIALS

Each lab group should have:

1) a set of rocks including; shale, sandstone, limestone, dolostone, salt, gypsum and coal. Be certain that the samples you use exhibit the characteristics given in the student guide. These are the rocks that outcrop at the surface in Ohio and therefore can be collected by the teacher. The Ohio Geological Survey, Fountain Square, Columbus, Ohio will provide a set of single specimens of Ohio rocks on request. They can be purchased, if necessary, from Ward's Scientific, Rochester New York.

2) A small jar filled with water and sediment. The sediment should be of mixed sand and clay.

3) A binocular microscope with watch glass and saturated salt solution.

4) A heat source: a candle, alcohol lamp or bunsen burner.

OBJECTIVES

When students have completed this investigation they will be able to:

1) Describe the environments in which each of the following sediments would be deposited: clay, silt, mud, shale, sand and sandstone; limestone and dolostone; salt and gypsum; coal, oil, natural gas.

2) Explain the relationship between the geological history of Ohio and its mineral wealth.

3) Explain why some areas of Ohio do not have as much mineral wealth as other areas.

SUGGESTED APPROACH

The investigation can be used in either an individualized format with each student having access to the necessary laboratory materials, or in a group laboratory with pre-lab and post-lab discussions. In the latter case, the student guide will have to be redesigned by pulling out the questions and duplicating them separately. The text information should be presented during the pre-lab or post-lab discussion.

If used in an individualized format, each pair of students should have available the set of rocks, since these are the most heavily used materials. One or two jars with sediment, and 4 or 5 microscope-and-salt-solution set-ups should be available at stations placed around the classroom.

The investigation could be preceded by the film Rocks that Form on the Surface, available from Encyclopedia Britannica Educational Corporation. The film describes sedimentary rocks, where they come from, what they are composed of, and how they are formed. It is 16 min. long.

You might want to use this investigation as an introduction to a unit on Ohio's energy supply. There is a great deal of concern about full exploitation of natural gas in Ohio. Ohio's coal has a great deal of sulfur in it which adds to pollution. Therefore, there is a problem in its use. The two methods now being used to reduce sulfur in coal are stack scrubbers and fluidized-bed boilers. Both use limestone to remove the sulfur.

ACTIVITY A

In this activity students examine and describe the common sedimentary rocks found in Ohio.

Keywords: Shale, sandstone, limestone, dolostone, oil, gas, coal, salt, gypsum, fragmental rock, organic rock, chemical rock.

1. Students should note that the fragments of rock in the jar settle out according to size. The sand settles first in a layer on the bottom and the clay settles last forming a layer on top.

2-3. The descriptions that students write of the types of rocks should be similar to those in the student guide but in their own words.

4. Note that no distinction is made in the activity between limestone and dolostone. If you want, you can provide some

dilute hydrochloric acid. A drop on limestone will fizz rapidly, whereas on dolostone it will fizz very slowly and many times only if the dolostone is scratched first. This is the easiest way the two can be told apart.

5. Try this out before you do it with your students. It may be that the tap water will have contaminants that would mask the precipitation and growth of salt crystals. If so, you may need to use distilled water.

6. Warn the students not to touch the watch glass with their fingers after heating it. They must use a set of tongs to hold the watch glass over the flame and to insert it under the microscope. The salt crystals should appear to be perfect cubes. You may want to have some table salt for the students to look at under the microscope.

7. Their descriptions should be similar to those in the student guide.

8. The coal is black and relatively light weight (low density). Students may discover vegetative remains in their samples. You might want to discuss the types of coal. Most coal in Ohio is bituminous. Other types are lignite which is very low grade and anthracite. Anthracite has undergone a certain amount of metamorphism and will be shiny black and quite hard.

ACTIVITY B WHAT DO OHIO'S MINERALS TELL ABOUT ITS HISTORY?

PROCEDURE The answers to these questions will depend upon the county of residence of the student.

1. Figure 1 is used to answer this question. In Franklin County, for example, most of the surface rock is Devonian.

2. Answer will vary. In Franklin County shale and limestone are produced.

3. To answer this question students will have to refer to the information in Activity A. Both the shale and limestone, for example, form in either lakes or seas. This would be the appropriate response of the students. In reality, fossils of marine animals have been found in both

the Ohio Shale and the Columbus Limestone found in Franklin County. Therefore, seas once covered that area. Actually, all of the rocks in Ohio that are older than Mississippian were deposited in a marine environment.

4. Since coal formed in swamps, you would need to go to the eastern part of the state where the coal mines are found, as indicated in Figure 4.

5. Most shale seems to be mined in the northeastern part of the state.

6. This shale was deposited either in seas or lakes.

7. Figure 1 indicates that the oldest rocks are found in the southwestern part of the state.

8. The mine is located on the shore. Figure 1 indicates that the surface rock is Devonian.

9. By referring to the cross section, students should infer that Silurian rock would be found below the mine under the Devonian and that it would come to the surface somewhere under the lake.

10. The area north of Cuyahoga County would seem to be the most likely spot for gas since the gas fields trend north-south through the county and, therefore, also go out under Lake Erie to the north. For a similar reason, the western basin of Lake Erie would seem to be the most likely place for oil.

11. Students might suggest problems of floating rigs in the lake and the expense of drilling from such platforms. Also, possible pollution problems.

12. From the geologic maps, students should surmise that the islands in the lake off Sandusky are composed of limestone or dolostone.

13. No. Students should realize from Figure 1 that Pennsylvanian rock does not underlie the lake.

REVIEW QUESTIONS

1. Although most of the following are not technically minerals they are usually regarded as part of the state's mineral resources: limestone, sandstone, shale, coal, oil, natural

gas, rock salt, gypsum.

2. Fragmentary rocks are formed from the cementing of fragments of pre-existing rocks.
Organic rocks are formed from the remains of plants and animals that die and fall to the bottom of lakes, swamps and oceans.
Chemical rocks are formed from minerals that precipitated out of evaporating water.

3. Coal is formed from plant matter that accumulated in ancient swamps.
Oil and gas are formed in mud deposited at the bottom of oceans and seas and later move into sandstones and limestones.

4. Rock salt, gypsum, sandstone, shale, limestone, oil and gas.

5. Limestone is likely to be forming in shallow tropical waters, such as around Florida, the West Indies, Australia and other places where reefs are forming. Coal is being formed in places where there are extensive swamps, such as in eastern Florida, the Gulf Coast, Central America and southeast Asia. Coal can also result from peat deposits in temperate and even arctic climates. Sandstone is being formed wherever sand is being deposited, such as deserts, stream beds, beaches and in near-shore shallow water of lakes and oceans in any climate.

6. This will be a difficult question for students to answer. You may have them do the following activity first. It could be done orally by the teacher if there is a time constraint.
From Ordovician time through Devonian time Ohio was covered by oceans that may have varied in depth. Beginning in Mississippian time, the ocean was much shallower and Ohio was still under water, but was close to a dry continent resulting in the deposition of sandstone. In Pennsylvanian and Permian time much of Ohio was still under this shallow sea. Eastern and southeastern Ohio had become part of a swampy coastline where coal was deposited associated with some sandstone and limestone.

ACTIVITY B
(Supplement)

MATERIALS

Figure 1, 4 colored pencils.

Table 1

County	Rock type(s)	Color
Hamilton	Shale, limestone	_____
Shelby	Limestone	_____
Franklin	Shale, limestone	_____
Ashland	Shale, Sandstone	_____
Guernsey	Shale, sandstone, coal	_____
Washington	Shale, sandstone, coal	_____

A. Fill in the third column of the table by selecting one of the colored pencils and placing the name of its color in the blank for each county. Use the same color for each county that has exactly the same rock types. For example, Hamilton and Franklin counties should be the same color since they both have shale and limestone at the surface. You should end up with only four different colors for the six counties.

B. Using the color scheme you just devised, color in each of the six counties using the appropriate color for each, on Figure 1.

C. Using the appropriate pencil, color in all the areas of Ohio that are the same age as the rocks in the 6 selected counties in Table 1, so that rocks of the same age will be the same color.

D. Describe Ohio's environment and how it changed from Ordovician time to Permian time.

_____

_____

_____

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*Available from the Publications Office, Ohio Department of Natural Resources, Fountain Square, Columbus, Ohio 43224.

EVALUATION ITEMS

1. Salt and gypsum deposits may form sea water as it

   1. settles
   2. cools
   3. heats up
   *4. evaporates

2. Clay, silt, and mud that are deposited far from the shore of lakes and oceans may eventually form

   *1. shale
   2. coal
   3. sandstone
   4. limestone

3. A rock that is formed from plant matter that accumulated in large swamps is called

   1. limestone
   2. shale
   3. sandstone
   *4. coal

4. A mineral that is mined from beneath Lake Erie is

   1. limestone
   2. coal
   *3. rock salt
   4. shale

5. Which of the following is an important source of energy found below Lake Erie?

   1. uranium
   2. salt
   3. coal
   4. limestone
   *5. oil and gas

6. Which type of environment occurred in your area when its rocks were formed?

    1. shallow seas
    2. swamps
    3. river flood plains
    4. hot and dry with evaporating sea

7. In what part of the state would the oldest rocks be found at the surface?

    1. Northeast
    2. Southeast
    3. Northwest
    *4. Southwest
    5. Central

8. What is the age of the rock below your area?

    1. Permian or Pennsylvanian
    2. Mississippian
    3. Devonian
    4. Silurian
    5. Ordovician

9. Sea water trapped in rocks is

    1. salt
    2. ground water
    3. oil
    *4. natural brine